MissouriEnergyInitiative

Leadership for our energy future

Dear Energy Forum Participants:

Please find attached to this letter, a series of discussion papers that roughly reflect the various breakout groups that will occur during our meeting on November 2, 2010.

These Discussion papers were solicited as a way to initiate thinking and discussion before and during the Forum. We want to maximize the amount of time we spend on productive conversation on November 2. Hopefully, these discussion papers will help us jump right into a productive dialog about the important issues.

Although we attempted to make the discussion papers broad and balanced in their coverage, there clearly may be ideas to which your object, as well as important topics that were omitted. This is good since it will make our discussions lively and will ensure that you come loaded with the key points that you feel need to be emphasized. The discussion papers do not reflect a MEI consensus…the Forum is where we hope that this consensus will emerge.

Please read the discussion papers prior to your arrival in Columbia on November 1 or 2.

One final point…it is human nature with these types of meetings to come with a personal agenda … or at least one that reflects the thinking of your organization. We encourage this to a point but want to emphasize that we are seeking long-term consensus in our discussions. Hence, your focus should not be on what happens next month, next year, or even the next few years, although clearly these issues will influence our discussions. We are after the 10,000-20,000 foot view, not what want would be seen down in the weeds. If we don't take this approach, we fear that it will be impossible to reach the consensus that is needed for our efforts to have impact.

This is NOT a strategic planning workshop that would identify goals, milestones and a timeline … instead, we are focused on the grand challenges that must be addressed to move our great State forward on the broad front of energy issues.

Other than good discussions and networking, the outcome of this meeting will be a report that highlights the grand challenges for Missouri in the energy area and makes long-term recommendations as to how to address these challenges. The intention is for this report to represent a broad consensus and, therefore, to be impactful on energy thinking and policy decisions in the state. After the workshop, a writing committee will seek to capture the major points and recommendations. MEI will then move aggressively to prepare this report and to be sure that it is widely distributed.

Again, thanks for your participation. We look forward to a very enjoyable, energetic and interesting Forum.

Gary Stacey	Roger Walker
MEI Acting Executive Director	Chairman, MEI Board of Directors.

Contributors of text and information for the discussion papers include (in no particular order):

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[MEI Board Members]

is proud to sponsor
by invitation only

Missouri Energy Forum --

Missouri's Energy Future

Hosted by the

University of Missouri

at the Reynolds Alumni Center

8 a.m., Tuesday, November 2, 2010

[Reception, 6 p.m., Monday, November 1, 2010]

FORUM AGENDA

Monday, November 1
6 p.m., optional evening reception at the Reynolds Alumni Center
Directions to Reynolds Alumni Center can be found at http://map.missouri.edu/?bldg=37376.

Tuesday, November 2
7:30 a.m. Registration, coffee and pastry
8:15 a.m. Opening remarks and welcome; Gary Stacey and Roger Walker
8:30 a.m. **Welcoming remarks: Gary Forsee: President, University of Missouri System; MEI Board Member**
8:45 a.m. "The Energy Future for Missouri and the Nation: Would Muir, Patton and Gandhi Agree?"
R. James Woolsey, a former director of Central Intelligence
9:15 a.m. Coffee Break

9:45 a.m. Break-out Groups

<u>Part I. Envisioning Our Energy Future: Opportunities and Roadblocks</u>

1. Energy Efficiency
2. Education and Training
3. Nuclear Power
4. Finance and Investment
5. Coal

11:15 a.m. Break-out Group Reports

NOON Lunch

Introduction: Former Governor Bob Holden, Former Congressman Kenny Hulshof
Special Lunch Speaker
"America's Energy Future: Missouri's Role"
Mark Wrighton, Ph.D., Chancellor, Washington University

1:15 p.m. Break out Groups
Part II. Envisioning Our Energy Future: Opportunities and Roadblocks

6. Renewable Energy
7. Research and Innovation
8. Transportation and Liquid Fuels
9. Electricity Transmission and Distribution
10. Natural Gas

2:45 p.m. Coffee Break
3:15 p.m. Break-out Group Reports
4:00 p.m. **General Discussion: Missouri's Energy Future: Next Steps**
5:00 p.m. Adjourn
Evening: Writing committee meets to draft meeting report

Discussion Paper
Energy Efficiency
November 2, 2010

Energy Efficiency: The Unseen and Critical Resource

Efficient energy use, or simply phrased, “energy efficiency” means reducing energy consumption while providing the same level of service to the end-user. For example, increasing a home's insulation lowers the amount of heating and/or cooling energy resources necessary to achieve and maintain a comfortable temperature. Or, it can mean replacing incandescent bulbs with compact fluorescent lights using one tenth the energy to produce equal or better lighting.

Energy efficiency saves money for consumers and businesses, lowers the stress on the energy grid, promotes home health and comfort, and, in sum, is simply a smarter way to power our communities and economy. In the coming years, as energy costs continue to rise, energy efficiency is a strategic approach toward more fiscal and environmental responsibility in modern resource and asset management.

Energy efficiency is often confused with "energy conservation", which is ‘doing without’. It is important to note that with new technological innovations, more efficient electrical and electronic components and infrastructure—and smarter ways to transport and fully realize the energy that we use—efficiency is about upgrading and modernizing the systems we employ that utilize energy, not merely 'doing without'.

Many studies like those by the American Council for an Energy-Efficient Economy (ACEEE) have proven that energy efficiency is the cheapest and cleanest resource immediately available to fulfill the needs of growing energy demand from our nation's economy.

Efficiency is the watt never used = the “negawatt”.

In fact, a 2009 study done by ACEEE proved not only that efficiency is the cheapest resource at about 2.5 cents per kilowatt, but that this resource has actually gotten cheaper over the last five years.

It is a myth that efficiency gets harder and more expensive to achieve. As technologies improve and experience grows in efficiency program management, more cost effective efficiency is found. So, efficiency is not only the “low hanging fruit” in our efforts to reduce energy costs but it is also always growing back. This is especially so where we can now use intelligent technologies – the intelligent communications technologies embedded in the Internet and smart chips. Information and energy technologies are increasingly being utilized in conjunction with one another producing new realms of efficiency that were unknown—or weren't even contemplated—in the past.

One recent study and resulting book demonstrates that the United States is utilizing only 13% of its energy potential – that we are 87% inefficient.[1] In reference to electricity, this begins at the point of generation where we lose on average up to 2/3rds

[1] “Crossing the Energy Divide: Moving From Fossil Fuel Dependence to a Clean-Energy Future”, Robert U. Ayers and Edward H. Ayers, Wharton School Publishing 2010

of the energy resource going into the combustion process to create the electricity. Then it leaves the plant by way of transmission/distribution wires where it loses an additional 7 to 10 %, finally arriving at inefficient household appliances and lights with further losses. This leaves room for a wealth of savings at all points in the signal path—real savings that can then be folded go back into the local economy in the form of more money for consumers to spend on other goods and expenses.

Many of the “green jobs” talked about are a direct result of the local investments we make in efficiency. New technologies and processes grow new jobs and businesses. Venture capital dollars are now chasing energy efficiency innovations as the newest investment opportunity in a constellation of segments that make up the clean energy sector. Nationally, tens of thousands of new jobs and many scores of new businesses related to energy efficiency will be created over the next decade, not to mention the much-needed revitalization of existing industries hardest hit by recession, like the building and construction trades. ACEEE studies prove that these new jobs will pay well, be based locally, and consequently, largely protected from outsourcing. In addition, studies show 90% of the construction materials used in residential energy efficiency are manufactured in the United States[2]; which will help to maintain and build new domestic manufacturing capacity.

Workforce development, consumer awareness and market demand are all valid concerns as this efficiency sector grows. This October, in a report funded by Department of Energy Office of Energy Efficiency and Renewable Energy[3], several energy efficiency program lessons are offered including the need for working closely with contractors as, "program ambassadors", utilizing trusted messengers with "buy-in from community leaders", and most obviously—but cannot be stressed enough—energy efficiency programs must sell something that people want. Effectively communicating the overlapping benefits of energy efficiency to both citizen and community is key.

With the obvious advantage that efficiency adds to our economy and individual lives, why is it not occurring more readily especially in certain states and regions in the United States? There are a number of long recognized barriers to greater efficiency especially in the electricity sector. Some of these barriers include:

1. Energy efficiency is invisible and diffuse. You don’t see insulation or caulking like you do a solar panel or wind turbine. No one sees the effect of retrofitting a home other than a lower energy bill once a month. This tends to devalue efficiency measures as less effective than they actually are.
2. Energy efficiency is not sexy. People naturally gravitate to that which is exciting and efficiency is not exciting.
3. Energy costs differ from state to state and from region to region. Energy is relatively cheap in states that continue to use coal or who have higher amounts of hydro-power. In states where energy costs are higher, like the Northeast, a greater amount of efficiency occurs. Traditional fuels like coal

[2] "Efficiency First HPR Center: DOMESTIC MANUFACTURING SHARES OF COMMON ENERGY REMODELING PRODUCTS"

[3] "Driving Demand for Home Energy Improvements", Environmental Energy Technologies Division Lawrence Berkeley National Laboratory

and oil are subsidized with taxpayer dollars keeping their real price impacts lower than they otherwise would be without the subsidies. This lowers the imperative to find greater efficiencies in utilizing them.

4. End-users cannot see time-of-day prices in real time. Being able to know when it is cheaper to use power to run the dishwasher or washer/dryer can substantially lower everyone's energy costs by reducing "peaking" – the time when everyone uses power at the same time. This is what utilities must build their infrastructure to meet so if we could level out usage over the full day especially during the night when energy is least used – as well as use less of it, we would all see lower energy costs.
5. Split incentives exist where a tenant occupies a building owned by someone else – someone who does not pay the energy costs and who has little incentive to either invest in more energy efficient appliances (which can cost more than non-energy efficient ones) or retrofits. Many multi-family housing units are built without efficiency as part of the construction plan leaving the tenants to pay higher energy costs than they might with efficiency in mind during construction.
6. Utilities are reluctant to encourage greater energy efficiency since their business model is predicated on ever greater sales of kilowatts and not fewer. Utility stockholders don't get paid for not producing sales and indeed their investment in more generation in the form of new power infrastructure (generation and/or transmission/distribution) is one of the major income producers for utilities. It is recognized that there are differences between restructured and non-restructured states but the point made here is the same.
7. Belief that efficiency is too expensive to produce. This is what many builders believe when in fact with new technologies and building procedures this no longer needs to be the case. Long held views change slowly and there is a great need to prove that housing can be built highly energy efficient at a reasonable cost.
8. Lenders do not give value to borrowers who invest in highly energy efficient buildings. The value of the lower cost to operate a building if accounted for in the ability of a borrower to repay a loan could mean the difference in acquiring the loan in the first place and/or being able to borrow a larger loan amount.

There are other barriers but this gives you a better understanding about the difficulty of encouraging and accomplishing greater energy efficiency even in the face of the fact that efficiency is good for everyone.

What are some of the ways we as a population can support greater energy efficiency?

Right now 24 states have an energy efficiency standard in place – almost 50% of all our states - and with the additional three states considering such a standard (this is not a renewables standard which also exists in some 30 states now), this represents two thirds of all the electricity sales in this country. These standards vary from state to state but all regions of the country have states with an efficiency standard. Texas was the first state in 1998 to establish such a requirement of the generators to reduce electricity use and they have since twice doubled the requirement after it was found to be relatively easy and low cost to meet it. Vermont is now saving enough through various efficiency programs and policies to turn their demand growth negative while their population continues to grow.

With such success at the state level, what this argues for, is a national energy efficiency standard that is achievable at a reasonable cost - a national energy efficiency standard that challenges us to do better than business-as-usual increases in efficiency gains.

Incentives and tax treatment are also proven means to accomplish greater efficiencies as well as energy building codes and standards. The recent stimulus investments in many energy efficiency programs and technologies will prove out given the time and workforce needed to accomplish the potential gains. If we can find a way to overcome the barriers listed above to gain greater efficiencies then we will all win. We will win with a greater potential for investments that make sense for everyone—especially local investments—in new energy technologies and processes that can put the country on a path to greater economic prosperity.

Discussion Paper
Education & Training
November 2, 2010

INTRODUCTION

Energy education and training is a broad topic. The breakout discussion will focus on two aspects: Public Education and Training Energy Industry Professionals.

PUBLIC EDUCATION

BACKGROUND

The U.S. Department of Energy (DOE), Energy Information Administration (EIA), regularly publishes the Annual Energy Outlook (AEO); the most recent version is the AEO 2010. Uncertainty exists in any of the various published energy forecasts but the Reference Case in AEO 2010 provides a discussion basis.

U.S. ENERGY CONSUMPTION GROWTH

The AEO 2010 Reference Case suggests that energy consumption will increase at an annual rate of 0.5% between now and 2035. The AEO 2009 also used a 0.5% annual growth rate while AEO 2008 used a rate of 0.7% and AEO 2007 used a rate of 1.1%. Although this series of forecasts has moderated the annual U.S. energy consumption growth rate, the implication of the 0.5% per year rate is an increase of 15% in overall energy consumption in 2035. It is important to appreciate the scale of the overall energy consumption and the growth. One characterization of U.S. energy consumption follows:

Present Annual Energy Consumption – 500,000 100-car Coal Trains

2035 Annual Energy Consumption – 575,000 100-car Coal Trains

In other words, if all the energy consumed in 2035 were provided from coal, AEO 2010 suggests it would take 75,000 more trains than at present.

CONSERVATION

Many organizations have for many years focused on energy conservation. Energy intensity is a measure of the rate at which energy is used to accomplish energy related tasks. Although it can be demonstrated that energy intensity has declined somewhat over a period of years, the rate of that decline has not been sufficient to restrain and reverse the growth trend. However, conservation remains the most cost-effective and responsible alternative for managing energy consumption. The AEO 2010 suggests that over 150,000 megawatts of new electric power generating stations will be required in the U.S. between now and 2035. Furthermore, over 40,000 megawatts will be additional coal-fired generating stations. The cost of new generation will be between 300-400 billion dollars.

Energy consumption conservation should be vigorously pursued in the U.S.

WHY HASN'T CONSERVATION BEEN AN EFFECTIVE STRATEGY

Although conservation has been an important initiative by many organizations, it has not been effective. Only modest gains have been demonstrated as a result of these initiatives. MEI suggests that many people do not appreciate the implications of their energy use and their energy decisions. If asked, many if not most people would be incapable of characterizing energy consumption and supply in the U.S. It has been suggested that 80% of an individual's annual energy consumption is the result of a personal decision, i.e., we all decide to drive, fly, use electricity, etc. Many of those decisions would be difficult if we decided to use the low energy alternative, e.g., a decision to walk to New York from Columbia, MO instead of flying is impractical but other decisions can be much more acceptable and effective.

MEI believes there are significant opportunities to promote energy conservation and that an important strategy is promotion of fact based, rational, and substantive education programs carefully designed for appropriate audiences.

EDUCATION AND BEHAVIOR CHANGE

Energy education and behavior change is a long-term proposition. MEI suggests that this process may be "generations" long, i.e., it may be necessary to train several generations of primary school students to lay the foundation for real change in energy consumption behavior. Recognizing that is will be a long-term process, fact based education should begin immediately. The initiative should be designed to serve at least four age groups: primary school students, secondary school students, high school students, and citizens at large.

BREAKOUT SESSION

This breakout session will explore the concepts outlined above. The following questions will serve to focus the discussion:

1. How well do people understand energy consumption and supply?
2. Do people understand that they regularly make energy choices?
3. Do they understand the implications of their decisions?

4. Why have energy conservation programs historically been only modestly successful?
5. Are children effectively taught about energy?

TRAINING ENERGY INDUSTRY PROFESSIONALS

BACKGROUND

As public awareness increases about energy costs and the implications of their energy decisions, service industries may emerge that focus on energy. E.g., today there are many service companies that will audit energy consumption and make changes to buildings designed to conserve energy. These emerging industries will require trained professionals.

Electric power utility companies have already begun to build system improvements that are designed to respond to concerns over energy management. The description “Smart Grid” is frequently seen in both news media and professional publications. It seems a wide range of new professional technical training requirements may emerge as the power industry evolves.

BREAKOUT SESSION

The breakout session will consider new industries and power industry training requirements. The following questions will serve to focus the discussion:

1. What new service organizations have already emerged or may emerge as public energy awareness increases?
2. What will be the training requirements for the professionals in these industries?
3. How will the training requirements for power industry professionals evolve?
4. What programs should be developed by Colleges and Universities?

Discussion Paper
Nuclear Energy
November 2, 2010

Overview: Nuclear power is a mature baseload generation technology; the nation's 104 operating nuclear units provide approximately 20% of the electricity generated in the United States. The world's 435 nuclear units provide over 15% of the global electricity generated. The U.S. nuclear fleet is performing well, with a fleet average capacity factor of 92% in 2009. This consistent, event-free operating performance has created favorable public opinion (recent Gallup polls show all-time-high favorability — 62% of all respondents are favorable toward nuclear energy; 28% strongly favor nuclear energy).

The future demand for nuclear generation is driven by its favorable greenhouse emissions and low operating costs. New advancements in technology along with the long experience of operating nuclear power plants will provide the supply technologies to meet this demand.

Background: Following the development of Generation 1 nuclear reactors in the mid-1950s and early 1960s, which were typically small (40 to 200 MW) came Generation II nuclear reactors. The nation's 104 Generation II light water reactors of up to 1,300 MW were built in response to the dramatic load growth the U.S. experienced in the 1970s and 1980s. The U.S. Gen II reactors experienced significant cost increases after construction started in the mid-1970s due to increased regulation, requirements for additional safety equipment after the Three Mile Island accident in 1979 and the high inflation of the period. Uncertainties over rising costs and a large decline in electrical load growth in the early 1980s led to the cancellation of many the planned units, including Ameren's original Callaway Unit 2, which was formally cancelled in 1982.

Generation III and III+ nuclear reactors are being currently constructed and continue to undergo some development. They are known as the advanced reactors and are similar to the Gen II reactors with notable economic and safety advancements. The Generation III+ reactors employ passive safety features rather than active ones, with controls using gravity or natural convection. The new designs are licensed by the U.S. Nuclear Regulatory Commission (NRC) for a period of 40 years; however, they have a design life of 60 years.

Currently in the U.S., 32 new nuclear units are under consideration. All are large scale Generation III+ units. Globally, nuclear power continues to advance. When the U.S. nuclear power expansion effort came to a halt in the early 1980s due to increasing construction cost, low load growth, and poor public support, there were approximately 200 power reactors in the world. That number has now more than doubled to 438 power reactors in operation. Over 50 power reactors are currently under construction in 13 countries.

Generation IV (Gen IV) nuclear reactors designs are in various stages of development. It is expected that these designs will not become commercially available until the 2030 timeframe. In addition to the higher thermal efficiencies of many of the Gen IV reactors, one of the major features for these reactors will be their ability to integrate into a closed fuel cycle. That is, the long-lived radioactive elements that are currently being treated as nuclear waste could be used as fuel in many of the Gen IV reactor designs.

Small Modular Reactors: Small Modular Reactors (SMR) have emerged as a new concept for electric generation in the utility industry. These units use the experience from nuclear-powered naval vessels, and are small in size (similar to the Generation 1 units, 40 – 300 MW), but combine many of reactor system components into a single module. Unlike traditional reactors, the SMRs would be manufactured and assembled at the factory and shipped to the site as nearly complete units, resulting in lower capital costs and much shorter construction schedules.

SMRs also permit greater flexibility through smaller, incremental additions to baseload electrical generation, and more SMRs can be added and linked together for additional electrical output as needed. Of the many contenders in this arena, only two have currently announced their intent to submit an application for design certification with the NRC, the B&W mPower reactor and the NuScale reactor. Both are to use Generation III+ light water Pressurized Water Reactor designs and are to be submitted for design certification in the 2012 timeframe.

Demand Drivers: The major factors driving interest in building additional nuclear units to respond to projected growth in electricity demand include:

- Carbon- and emission-free generation. . Desire for energy security and independence. .
- Low Operating Costs. Compared to other large-scale central stations, nuclear plants can be more expensive to construct, but less expensive to operate. Higher construction costs are mainly associated with safety and security requirements, including both design/construction requirements and lengthy licensing process. Low operating costs are a result of lower marginal fuel cost. Therefore, nuclear plants can be cost-effective when they are operated at high capacity for many years. Due to the low operating costs of nuclear reactors, their electricity generation costs have historically been more stable than those of coal or natural gas-fired plants. .
- Lower total capital costs for SMR will increase demand for these reactors since they would be more affordable. Experience gained from the construction and operation of new nuclear plants in the U.S.and other countries will also determine future demand.

Supply Drivers: The major supply drivers for nuclear energy include:

- Potentially lower overall cost when the significant capital investment is allocated over the high capacity factors of these large baseload plants.
- The major forgings utilized by vendors to manufacture reactor components have been identified as a bottleneck for supply thus driving up costs and potentially delaying schedules. Forging manufacturers are in the process of responding to these demands by increasing their manufacturing capabilities.

- The future availability of a skilled nuclear workforce is another important consideration for nuclear generation. .

- Shorter overall schedule/timeline for licensing, permitting, design, construction, and commissioning as compared to historical time frames. .
- Longer intervals between refueling outages, with the potential that total plant outages are not needed anymore. .
- The introduction of SMRs that with their smaller capacity sizes make integration with load growth more congruent. .
- Improved operational efficiency and lower O&M costs.

The Utility Viewpoint: In the new 20years, two types of nuclear technologies are considered potential options for future generation. These are the Generation III/III+ large scale nuclear power plants and the light water versions of Small Modular Reactors. These technologies have the U.S. NRC licensing schedule to support deployment in this timeframe and appear to have a high degree of commercial viability.

The large experience knowledge base developed over the past 30 years in operating Generation II nuclear plants has been incorporated into the Generation III and III+ designs so that these units will provide increases in safety margins, constructability, and operational efficiency. For the large-scale plant designs, these efficiencies include a small number of vendors using standardized designs. Depending on the vendor, some provide modular construction, larger reactor cores with improved thermal efficiency (up to 39% vs. today's 34%), passive safety system designs with less equipment or full 4-train safety systems capable of online maintenance, and station-wide digital control systems. These design factors will result in improved efficiency and lower O&M costs. SMRs incorporate many of the design features discussed above. Most SMR designs have inherent and passive safety features. In addition, two of the chief safety risks of large reactors—the buildup of decay heat and breakage of major piping in the primary loop—are of much less concern in SMRs. Additionally, as discussed before, these small units provide other distinct advantages over large reactors designs.

Other points to consider: While the high costs of nuclear energy are often discussed, these discussions often minimize the impact. As with essentially all newer technologies (wind, solar, nuclear), the capital costs can be daunting, even with their modest operating costs. These capital costs, without governmental intervention, limit the penetration of all these resources – and again, not only for nuclear, but wind and solar. The current government loan guarantee program has spurred the construction of two new nuclear units in Georgia, and is also supporting wind and solar projects as well. These programs have the advantage of lowering interest on capital with the government standing behind the loan, and do not cost the taxpayers anything if the project is completed as planned. But without some help, capital intensive projects may not happen.

The lack of a thorough discussion of nuclear waste disposal in the paragraphs above should not go overlooked. Although the general consensus is that on-site storage is safe for as much as 2 or 3 centuries, the lack of an identified solution limits public acceptance.

The small modular reactor concept has been around for a long time (well over 40 years). There seems to be a good deal of renewed interest, perhaps driven by the high capital costs of the larger units. It is hard to determine if this new interest will result in something being built this time around.

Gen IV reactors for the future should have many advantages: better efficiency, the ability to produce hydrogen, better fuel utilization leading to less fuel waste. However, the time scale mentioned above for their ultimate implementation may be optimistic.

Missouri Energy Initiative
Finance and Investment
November 2, 2010

Snapshot of the Investor-Owned Utility Environment

- Economic
    - Demand for energy fell in the recession on a weather-normalized basis
    - In response, managements cut costs and capital expenditure budgets
        - Some required spending pushed to future periods
    - Energy demand has increased slightly this year (on a weather-normal basis)
    - Regulators have been generally supportive in approving higher rates and allowing timely recovery of higher commodity costs and costs of environmental compliance

- Capital Markets
    - Regulated utility businesses generally have higher credit profiles than the average U.S. industrial company and have excellent to strong business risk profiles (Source: S&P)
        - U.S. electric utility average rating = 'BBB' (investment grade)
        - U.S. gas utility average rating = 'A' (investment grade)
        - U.S. industrial company (average) = 'B' (non-investment grade)
    - As a result, capital markets have been open for utilities in 2009 – 2010
        - Significant amount of debt financing and refinancing at very low rates
        - Proactive pre-financing of future capital needs
    - Banks have been willing to renegotiate credit facilities, although with tougher terms
    - Investor-owned utilities need access to debt and equity capital markets to fund future capital expenditures
        - Interest rate risk
        - Risk of lower equity valuations
- Challenges
    - Managements have been conservative, but now need to consider strategies for future growth in a resource-constrained environment
        - Repowering of older generation plants (coal to natural gas)
        - Increased availability of natural gas
        - New nuclear generation plants
        - Investment in non-regulated activities increases credit risks
    - Regulators may be reluctant to increase rates for consumers affected by recession
        - Setting rates to allow 'fair' equity returns for investors; effect of regulatory lag

    - Compliance with tighter environmental standards
    - Compliance with renewable portfolio standards

Financing Renewable Energy Projects in the Current Market

- RPS standards driving development of many renewable energy projects
    - The current cost of energy provided by renewable sources is much higher than energy produced by traditional fuels
    - Government incentives required to build the projects

- Investors in renewable energy projects analyze the following credit drivers to determine risk
    - Terms of the off-take contract
        - Contracted cash flows vs. merchant risk
    - Financial strength of the off-take counter-party
        - Credit rating of the electric utility buying the electricity
    - Ability of the project owner to pass on increasing feedstock costs
        - Increased cost of wood chips for a biomass-to-electricity plant
    - Projected availability of the feedstock over the life of the energy contract
        - Availability of livestock waste for an anaerobic digester project
    - Technology risk
        - Has this technology been used successfully in other commercial operations using this feedstock?
    - Construction risk, operations and maintenance risk

- There are sources of equity financing for renewable technologies and renewable projects
    - Equity investors demand typical equity returns that depend on the risk of the project
        - 15 – 20% for lower risk projects to 25 – 30+% for higher risk projects

- Traditional sources of debt financing for renewable sources have dried up
    - Bank financing
    - Tax equity
    - Only the largest renewable projects sponsored by big, experienced developers are currently being financed by banks with a global footprint
        - J.P. Morgan, BofA, Wells Fargo, European banks
    - Smaller renewable energy projects (<$100 mil), in general, don't have access to bank financing and must rely on the institutional debt sources (insurance companies, hedge funds, etc.) for funding
        - Regional and local banks don't have renewable energy underwriting expertise

- Renewable energy projects depend on government incentives to provide adequate returns to equity investors, e.g.

    - 1603 grants
    - State solar renewable energy credits (NJ, California)
    - State grants for fuel cell projects (California)
    - ARRA tax-exempt bond programs (QECBs, RZBs)

- Developing new renewable energy technologies in the current market requires federal guarantees, as the technology risks force project debt investors to offer financing terms that drive down equity returns
    - DOE loan guarantee program
    - USDA 9003 Bio-refinery loan guarantee program (advanced bio-fuels)
    - In order to finance new technologies, government is bearing the technology risk
    - Expensive for project developers to apply (time, money)
    - These programs have made a handful of commitments

Discussion Paper
Coal
November 2, 2010

Overview:

Some important facts that must be considered when discussion the future of coal:

- World energy consumption is projected to increase by 44% by the year 2030. [1]
- Coal provides 41% of the world electricity generation, and 49% in the U.S. [2,3]
- Coal accounts for 80% of electricity generation in China. [3]
- China is the world's largest consumer of coal (48 quadrillion Btu), using more than double the amount in the U.S. [3]
- Carbon Capture and Sequestration can account for 20% of global mitigation by 2050. [4]
- Approximately 3,600 miles of CO_2 pipeline operate today in the United States for enhanced oil recovery. [5]
- The U.S. holds 28% of world proven recoverable coal reserves. [6]
- Renewable energy sources (biomass, biogas, hydro, wind, solar, geothermal) provide for 18% of total world electricity production, [3] of which:
    - hydro sources provide 16%, [3]
    - bioenergy sources provide approx. 1%, [3] and
    - wind, solar, and geothermal combined provide approx. 1%. [3]

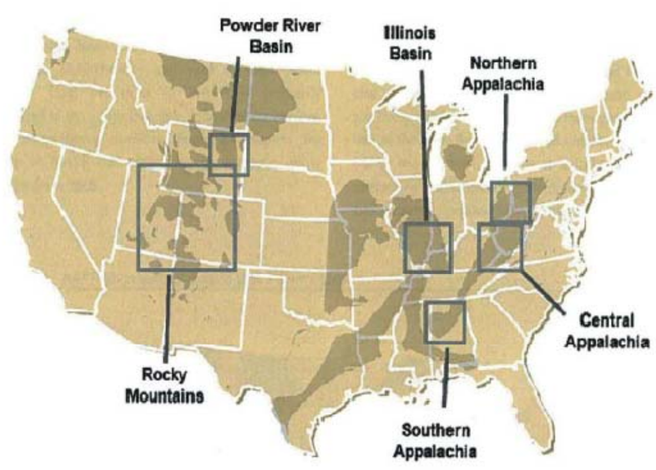

Figure Coal 3 — Coal Producing Regions in the U.S.

The above statistics illustrate that coal is integral to world electricity production. Furthermore, the IEA predicts that in the foreseeable future there will be an expanded use of coal worldwide. While some analysts project that coal use will decline in the U.S., few doubt that it will continue to fuel a major part of the U.S. electricity generation, largely because of its abundance, as seen in Figure Coal 3. Moreover, in emerging economies — particularly in China, coal use will continue to grow rapidly.

When we consider the primary requirements for any future energy sources, the following conditions should be met:

1) Electricity must be affordable, and any change in pricing cannot disrupt established economies or cripple the growth of developing nations.

2) Electricity must be reliable. Industrialize countries depend on a steady, reliable electricity supply to fuel their economies. An electricity supply that is unreliable could be catastrophic for established economies and would hamper the growth of developing countries.

3) Future sources of electricity should be such that they promote geopolitical stability, and should definitely not be destabilizing. When nations are dependent on others for their energy, this is an unstable scenario. Thus, countries with major populations should rely on indigenous sources of energy for their electricity supply. Also, sources of energy, like nuclear, that can lead to geopolitical instability due to nuclear proliferation, must be used with caution, even by those countries that traditionally have had stable, democratic governments, because if these governments rely on nuclear energy, it will not be possible to curtail the use of nuclear energy by hostile countries like Iran.

4) The source of energy must have minimal impact on the environment, both locally and globally.

For items 1-3, coal is king. Coal is affordable, reliable and is indigenous to China, India, Russian and the United States. China is already the world's leading coal producer, and along with India will account for over three-quarters of the anticipated 3.3 billion-ton increase in coal production in 2030 over 2004. Half the world's proven reserves are in United States, Russia and China. Figure Coal 4 shows the global breakdown of the nearly 1 trillion tons of proven reserves of coal as of 2005.

Environmentally, coal has challenges, but the fact that it stands alone among the alternatives with respect to items 1-3, behooves us to work to identify solutions to its environmental challenges.

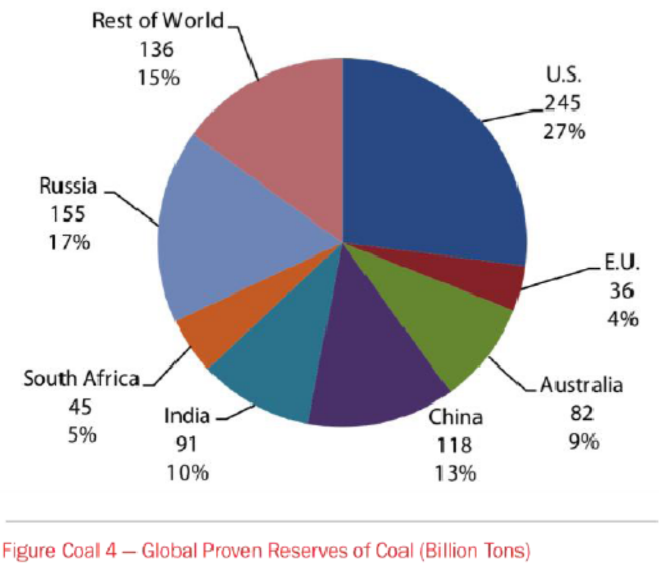

Figure Coal 4 – Global Proven Reserves of Coal (Billion Tons)

One of the difficulties that we face in the U.S. is that while logic would dictate that the U.S. should lead the world in promoting the use of clean coal, political factors often stand in direct conflict with logic. Consider the following: the U.S. holds 28% of the proven coal reserves worldwide, so our energy security is ensured for hundreds of years if we rely on coal. Furthermore, in the event of a world shortage, the U.S. is likely to be the swing provider of coal. In addition, since coal reserves are distributed throughout the world and particularly in regions with large population centers, a greater use of coal worldwide might allow the U.S. to reduce its global military presence, which is presently needed to ensure stable energy supplies and avoiding nuclear proliferation.

Another political debacle that is leading to poor decision on energy is the “dash to gas.” As utilities scramble to increase their capacity in the absence of a well-defined carbon policy, the short-term solution is natural gas. However, from a strategic position this is illogical. Natural gas is an extremely valuable fuel. It is ideal for residential and industrial use and can be used as a transportation fuel. Despite recent discoveries of shale gas, reserves of natural gas are limited and it would be an enormous loss if this valuable irreplaceable resource went to fuel stationary power plants that could have been run off coal, when coal, unlike natural gas, has limited use outside of electricity generation.

The critical challenge facing coal is its impact on the environment. Nonetheless, history has shown that technologies can be developed to dramatically reduce the environmental impact of coal. While control of carbon has significant technological challenges, the greatest challenges appear to be economical and political, rather than technological. Nonetheless, if the remaining technological challenges can be addressed in a way that ensures public acceptance, the future of coal can be secured.

An Opportunity for Missouri

Missouri is poised to play a major role in the future of low-carbon coal utilization.

- Over 80% of Missouri’s electricity is produced from coal and this has allowed Missouri to have some of the lowest cost electricity in the nation.

- Across the river is the Illinois Basin, with coal reserves having an energy capacity comparable to Saudi Arabia’s oil reserves. The Illinois Basin has more than 150 years’ worth of reserves at current extraction rates.

- Southern Missouri is home to the largest cement and lime kilns in the world. These plants benefit from low-cost coal-based electricity but they also have a significant challenge with respect to carbon dioxide. The kilns consume large amounts of fossil fuels and the calcination process releases large amounts of carbon dioxide when quicklime is produced. Thus, these carbon-intensive industries need a solution for carbon management.

- The future home of the world’s largest CCS demonstration project, FutureGen 2, will be in Meredosia, Illinois, just 100 miles north of St. Louis. Ameren, the fifth largest utility in the nation, with headquarters in St. Louis, will manage the facility. This facility will employ oxycoal for the capture of carbon dioxide and the CO2 will be sequestered nearby.

- Washington University has just completed a 1 MWt oxycoal research facility that will be able to supply research support for the FutureGen 2 project. In addition, Washington University is home to the Consortium for Clean Coal Utilization, whose sponsors include three major companies based in Missouri, Peabody Energy, Arch Coal and Ameren.

- University of Missouri, Kansas City has DOE support for a systematic large-scale computational study of advanced alloys based on refractory metals such as molybdenum that will have acceptable mechanical properties at high temperature. These materials can be used to dramatically increase the efficiency of coal power plants and thus reduce greenhouse gas emissions.

- Washington University's Photosynthetic Antenna Research Center in St. Louis and the Donald Danforth Plant Science Center received $64 million dollars from the U.S. DOE to fund research related to algae for biofuels. Missouri, with its abundant access to water, flat land, fertilizer and even its own unique algae strain native to the state, could make the state a "hub" for algae-to-fuel production utilizing CO2 from coal fired power plants.

With this concentrated focus on coal, Missouri has the potential to be a world leader in demonstrating the realities of clean coal utilization. The challenge is to organize our efforts in collaboration with surrounding States like Illinois, and build a directed effort that leads to significant support from Federal and State governments and industry.

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Discussion Paper
Renewable Energy
November 2, 2010

This discussion paper is written to stimulate thought, discussion and dialogue on future energy technologies and sources that can fuel the economic growth and development of our country and Missouri. This article will present a brief description of what's happening in renewable energy on a global scale and hopefully stimulate some thought about Missouri's role and scope in the global energy world that is in search of the future where energy is clean, affordable, reliable and sustainable. This future will include many sources of energy – there is no silver bullet that will replace fossil fuel energy. What we need is a transition from our present energy economy to a new energy economy. What we need is exploration of the potential of many sources of energy (silver buckshot) that will provide a transition from the silver bullet of carbon-based energy to the silver buckshot of additional energy sources. This is not an article written to defend or support any given energy source or technology. Sheik Amandi of Saudi Arabia perhaps captured the essence of the transition we must traverse to move beyond the oil age when he said:

> "The stone age did not end because of the lack of stone.
> Undoubtedly the same will be true for the oil age!"

What is happening today with renewable energy technologies and what is their potential role in this energy future?

According to EIA's latest data, renewable energy supplied just over 7% of the US energy consumption or 7.34 Quads of energy in the US in 2008. This is an increase from 6.25 quads supplied in 2004.

SOLAR

Solar energy both solar thermal and PV has been growing rapidly globally due to improved technology and various government incentives. In 2009, 10,700 megawatts of PV cells were produced globally, a 51-percent increase from the year before which compares to an 89 % growth in 2008. China leads in manufacturing PV cells, (3,800 megawatts in 2009). Filling out the top five manufacturers are Japan, Taiwan, Germany and the United States. Globally at the end of 2009 approximately 23,000 megawatts of PV was installed in more than 100 countries (sufficient to power 4.6 million U.S. homes). The PV manufacturing industry continues to change rapidly. In 2004, Japan dominated but today has just 14% of the market,

WIND

The Global Wind Energy Council predicts the installed wind power capacity will fall just short of the 200GW mark by the end of this year (about three per cent of global energy capacity). Furthermore, they projected that 40GW of new capacity will be added during 2010 and a doubling of capacity to 400GW by 2014. Steve Sawyer, secretary general of the Global Trade Association, suggested that growth is likely to be driven by China, Europe and a recovering US, but anticipated South American and North African nations will also play an increasing role in the global wind energy market.

GEOTHERMAL

In 2009, worldwide, about 10,715 megawatts (MW) of geothermal power is online in 24 countries. This is an increase from approximately 5,800 megawatts installed in 1990. An additional 28 gigawatts of direct geothermal heating capacity is installed for district heating, space heating, spas, industrial processes, desalination and agricultural applications. Historically geothermal power was limited to tectonic plate boundaries; however, with recent technological advances the range of this technology has increased significantly with impressive market growth in the ground source heat pump sector for heating and cooling buildings especially residential homes.

BIOMASS

Biomass has many options as an energy source – electricity, liquid fuel and thermal. Since biomass is the main source for liquid fuel production, there is much interest (in part generated by government policies and market mandates) in biofuels produced from biomass, resulting in a global biofuels demand projected to grow by 133% by 2020. In the US the 36 billion gallons of alternative fuels by 2022 is huge mandate. Some estimates predict the global demand will be short by 8.5 billion gallons (5 billion gallons for ethanol, and 3.4 billion gallons for biodiesel). Brazil and the U.S. lead the way in global ethanol demand followed by China, Japan, UK and Germany. Mainly because of its favorable GHG profile these countries are looking to Brazil’s advanced sugarcane bio-ethanol for supply with and with limited commercial volumes of cellulosic ethanol. Brazil, India, Spain, Argentina, Indonesia, Germany and the United Kingdom are expected to have significant demand growth for biodiesel by 2020.

THE TRANSITION

In the US, the 500-pound canary in the energy market is the Department of Defense (DOD). DOD has the goal to be the “demand signal” for renewable energy and energy efficiency. Included in this goal is an aggressive program to develop aviation biofuels, electricity to operate ships and enhanced energy efficiency. The Air Force will have all its aircraft 50% biofuel certified by the end of next year. What is significant about drop-in aviation biofuel? There are less than 100 aviation fueling stations to prepare for biofuels in this country juxtapose to the ten of thousands automobile fueling stations. Thus a change can happen quickly. In addition the quantity required to meet DOD’s goals is significant – 8 million barrels/year of biofuel by 2020 for the Navy and 5 million barrels/year aviation biofuels for Air Force by 2015.

The New York Times recently published an article on the military’s move to renewable energy. “Why is the military investing in renewable technology? It is security of this nation and safety of fuel transport in hostile environments. Shipments of solar tent shields and computer chargers have been delivered to Afghanistan's Helmand Province. Military leaders say they hope to have half of Navy and Marine power generated by renewable sources in a decade's time. It costs $400 to get one gallon of gas deep into the heart of Afghanistan, and one soldier or civilian protecting the shipments dies for every 24 hours fuel convoys winding their way across the Middle

East. In addition to rolling out alternative energy technologies across Afghanistan, the military has been moving away from fossil fuels in other quarters. Last year, the Navy launched a hybrid amphibian-assault ship that runs on electricity when cruising at low speeds, and the Air Force is introducing biofuels (including algae) for its jets. There's even talk of a biofuel plant in a truck that can turn illegal poppies into a power source."

THE CHALLENGES

The recent renewable energy technology advances; the federal and state mandated incentives for renewables, the volatile fossil fuel prices, and the growing interest in sustainability are all prompting interest in renewable and clean energy practices. At this time in our energy history, we have the opportunity and sufficient time to create a new energy vision for Missouri and transition to a new energy future unlike our missed opportunity of the 1970's during that bell-ringing Arab Oil Embargo experience.

The challenge is establish the vision and develop the plan on how we will make the transition to a future where energy is clean, abundant, reliable and affordable. Renewable energy cannot give us this future by itself but it has a place in this future.

Should we be in the process of transitioning to this energy future now - from traditional energy sources to new energy sources and energy efficiency that enhance economic development? YES.

The very fact that MEI exists is to create the dialogue for this transition to happen and demonstrate that the "Show Me" state will show the rest of the country it is on the cutting edge of a new energy future. Applicability to Missouri, and when and how Missouri joins this new global energy happening, is in part what this Summit and MEI is all about.

What is Missouri's future in this new energy world?

What do we do or should we be doing to position Missouri as an economic force in this new energy world?

The challenge is to begin the process of defining the "silver buckshot" that will be a part of Missouri's energy future.

MEI provides a platform IF we all engage in the process.

Discussion Paper
Transportation of Liquid Fuels
November 2, 2010

Movement of liquid fuel in Missouri is heavily dependent on two primary sources of transportation and two secondary sources. Pipeline transport and over-the-road truck transport are the primary methods with much smaller amounts being moved by rail and barge.

Pipelines

The pipeline infrastructure in Missouri moves liquid fuel products from supply sources in other parts of the continental United States to the state for consumption. Missouri has no refining capacity for gasoline, diesel fuel or propane within the state. There is petroleum refining in the border states of Kansas, Oklahoma, Illinois and Tennessee, so we are not totally dependent on pipelines to get liquid fuels into Missouri.

With at least four main pipeline systems moving through the state, supplies can be moved from various parts of the country to terminals and supply points throughout the state and along the borders. Current pipeline infrastructure in place includes the following key systems for gasoline and diesel fuel:

- Magellan – ships products from Texas, Oklahoma and Kansas
    - Delivers to key terminals throughout the state
- Explorer – ships from gulf refineries and gulf import terminals
    - Delivers to other pipelines and terminals in Missouri
- Enterprise – ships from Texas and gulf refineries and import terminals
    - Delivers to terminal in Southeast Missouri
- ConocoPhillips – ships from Texas and Oklahoma
    - Delivers to various terminals throughout the state

For propane, pipeline infrastructure in place includes the following key systems (all terminals deliver within Missouri or along the borders):

- Enterprise – ships propane from Kansas , Oklahoma, gulf refineries, gas plants and imports
- ConocoPhillips – ships propane from Texas and Oklahoma
- NuStar – ships from Kansas
- Magellan – ships from Kansas

There are also various crude oil and natural gas pipelines that run through and provide service to customers in the state. Most pipelines are integrally connected somewhere in the system to move supply from various production points to multiple distribution supply terminals. Pipelines that run though Missouri either transport through the state to other areas of the country or are connected to terminals where shipped products are loaded into trucks.

Currently, the transportation system operates very efficiently. There is mutual cooperation between pipelines, terminals, truck transport carriers and customers to assure a very efficient distribution system. Under normal operating conditions the functionality of the system provides the service the industry and customers require.

However, there are potential challenges that could the test the system and its functionality and efficiency.

Those challenges include, but are not limited to:

- Weather
    - Ice
    - Hurricane, tornado, etc
    - Extended period of weather extremes
- Geopolitical issues
    - Disruption in crude supply
    - Price increase in crude oil
    - Reduction in refining capacity
    - Fear factor of war or terrorism
- Domestic issues
    - Inflation/value of dollar/economic conditions
        - Poor economy – plenty of supply
        - Robust economy – tight supplies
    - Domestic Terrorism
        - Short term rush on supply
        - Long term supply destruction
- Damage to infrastructure
    - Communication systems
    - Electric generation
    - Pipelines , roads, bridges

Functionality considerations for pipeline and terminals are as follows:

- Pipeline integrity
    - Testing, maintenance and replacement is ongoing, but the system is aging and subject to more maintenance and replacement as it get older
- Dependence on electricity
    - Pump stations to move the products in the line
    - Product movements from tanks to pipe
    - Valves and gauging at terminals and within the system
    - Pumping the products into trucks
- Dependence on communications
    - Product movement
    - Gauging and pressure monitoring
    - Valves and control
    - Measurement
    - Product ownership and control
    - Movement and loading authorizations
- Dependence on continuous supply
    - The system is heavily dependent on a constant supply coming into the pipe
    - The products only move if there is something to push them further up the pipe

  - There must be buyers and sellers
  - Need constant refinery production which requires crude oil availability and no disruptions
- Tertiary storage
  - Products in the pipeline and terminal storage represent a very small portion of total capacity – government regulation of storage tanks and volatility of the markets have diminished our capacity to store products for the "rainy day"
- Potential for allocation
  - Allocation occurs when there is more demand than supply. Priorities have to be set, and either someone will not get product as ordered, or delivery cost will be increased to compensate for added cost of transportation or competitive market for the incremental amount over allocation

Truck Transport

The other key component for movement of liquid fuel is the truck transportation portion of the process. Functional considerations of over-the-road transport of fuels includes:

- Government Regulations
  - Regulations specific to the transportation of hazardous material - not every vehicle or driver can haul liquid fuel
    - Vehicle testing and certification
    - CSA 2010 initiative may limit available drivers and equipment
    - "wet line" regulations
    - DOT hours of service
    - Driver requirements and endorsements
    - State tax and permit requirements

  - Regulations regarding fuel specifications and quality "boutique fuels"
    - EPA mandated fuel requirements regarding vapor pressure
    - EPA mandated fuel requirements regarding oxygenates (ethanol)
    - Diesel fuel specifications
      - Sulfur requirements
      - Tax and dye issues
  - Sub grade gasoline due to mandates or economic incentives
    - Requires use of ethanol
- Fleet size and capacity
  - System currently designed as "just in time" distribution system, very little surplus capacity
  - Fleets are sized for "normal" distribution of loads based on most economic supply source
    - Change in supply source will affect the effectiveness of delivery system
      - Longer drive times
      - Potential waiting times – trucks coming from different areas when supply is not available at normal source
      - Allocation limiting supply

        - Trucks, tanks and drivers are licensed and certified for specific terminals
            - Will require lead time for set up of records at different terminals
        - The cost to maintain a fleet for less than optimal economic performance is not practical in normal circumstances
- Driver Issues
    - Certification and training
    - Hours of Service
    - Safety
    - Terminal approval and training

Effect of Biofuels on Missouri Liquid Fuel Transportation

Missouri has an advantage of having a plentiful supply of biofuels infrastructure, including production capacity and feed stock. With numerous plants providing ethanol and biodiesel to the market, it reduces our demand for gasoline and to a lesser extent, diesel fuel. However, there are complications related to production and distribution of biofuels.

Potential production issues – specifically ethanol:

- Dependence on inputs
    - Corn
    - Water
    - Natural gas
    - Electricity
    - Natural gasoline
- Dependence on transportation
    - Bring in the corn
    - Haul out the ethanol
    - By-product distribution, including DDG and carbon dioxide
- Dependence on terminal for blending
    - Cannot be used without gasoline blending in significant quantities

The current mandate of ethanol in our gasoline supply supports the building of infrastructure to provide additional motor fuel in the event of a crude oil shortage or refinery disruption. The mandate has added value to production in Missouri and contributed to the capacity output of the plants. The current mandate does not inhibit the ability or the capacity of terminals to distribute gasoline or diesel fuel. Consideration must be given to the implication of future mandates to be certain they do not cause terminal or supply capacity to be diminished due to the potentially high cost and low return on investment in what may be an underutilized asset. A mandate to blend in an unprofitable situation may cause a decision to reduce the infrastructure currently in place. Parties involved in any decision regarding mandates must build trust in each other to be assured full and complete understanding of all issues are taken into consideration.

Rail and Barge

When MFA Oil was founded in 1929, a significant portion of gasoline and diesel was transported by rail. Bulk plants were located in railroad rights of way to allow unloading of fuel from rail cars into storage tanks. Most of those plants have been relocated and currently no gasoline or diesel is transported by rail. Propane, however, is still transported by rail in significant quantities. There are rail sidings and storage tanks capable of delivery of propane by rail. Although economically it not always a viable alternative, infrastructure is in place to allow transportation of propane by rail in significant quantity. The lead times required in securing rail cars and line space can be difficult to schedule. Typically, rail transportation of gasoline, diesel and propane is not a short term solution to a transportation problem. Rail is very important for the transportation of ethanol and biodiesel produced in Missouri to areas outside the state, but not so much for distribution within the state since production facilities are not far enough away for rail to be competitive with trucks.

Barges also have provided a significant amount of liquid fuels to a few terminals along the Mississippi River. As in rail transportation, the lead times and scheduling of barges can be difficult. There are still several terminals that have connection to barge terminals in Southeast Missouri, St. Louis and other places. Petroleum products produced at refineries in the gulf and as far up as Memphis, TN can be loaded into barges and moved up the river to be consumed in Missouri.

Discussion Paper
Electricity Transmission and Distribution
November 2, 2010

Overview: Growth in transmission investment will increase dramatically in the period as the industry addresses key public policy goals that include expanding access to renewable resources and responding to reliability issues. New transmission development will also help reduce congestion in wholesale markets and facilitate continued smart grid development and efficient operation of the electric system.

As national energy policy focuses on reducing our carbon emissions and our dependence on foreign energy sources, federal policy makers view transmission development as a key initiative in energy policy implementation. They seek greater control over transmission development, including authority over transmission planning and assumption of roles traditionally filled at the state level, e.g. transmission permitting, siting, and right-of-way acquisition.

The growth in transmission investment will attract new market entrants and lead to innovative corporate structures to finance the construction and ownership of transmission assets. Merchant transmission developers will continue to seek to capture the financial rewards of potentially billions of dollars of new investment. Unlike their predecessors in merchant generation development, these new entrants are guaranteed cost recovery with a regulated return, often with financial incentives above traditional utility returns. These entities will compete with existing utility transmission owners for the right to build.

While significant investment in transmission is necessary to support national policy objectives, cost allocation and recovery issues remain to be solved. The utility industry expects that federal regulators will take control of cost allocation processes related to investments in high voltage lines (345 kilovolts and above). Whether determined at the federal or state level, cost allocation and recovery for new transmission investment will apply without regard to who built and owns the transmission. With Federal Energy Regulatory Commission (FERC) incentives, utilities could begin recovery for transmission investments prior to the assets being placed in service at the federally regulated rate of return on equity.

Background: Policy analysts estimate that the United States will need to invest $298 billion in new electric transmission from 2010-2030. This is double the current book value of electric transmission in the United States. Recent experience demonstrates that this increase in investment is already beginning to occur. In 2007, investor-owned utilities spent $7.8 billion on new transmission investment, as compared to a 30-year historic annual average of $2.7 billion ($4.5 billion in 2006 dollars). This investment comes in response to several issues in the industry: demands related to integrating renewable resources (particularly wind generation); requirements for maintaining reliability; changes in market dispatch related to climate legislation and other congestion issues; and lastly replacement of aging infrastructure to serve projected growth in electric demand.

A return on equity of 12.38% is the allowed return under the Midwest ISO FERC approved transmission tariff's Attachment O. This rate applies to all customers in Illinois. The Missouri Attachment O rate applies only to wholesale customers today. For Missouri retail customers, the transmission cost recovery is a part of the rate approved by the Missouri Public Service Commission

Supply Drivers: As the transmission landscape changes, the business is becoming more complex. A number of multi-party, multi-state projects have been proposed as utility partnerships or limited liability corporations. In addition, new entrants to the transmission business, like LS Power, plan to operate as merchant transmission developers, challenging existing utilities' rights to build in their own territories. A few examples of these projects include: . Green Power Express – Proposed by ITC, this $10-12 billion, 3,000-mile, 765-kilovolt (kV) network across the upper Midwest is intended to move up to 12,000 MW of wind generation. MDU Resources was the first company to sign up as a partner in the project. ITC continues to solicit other partners, including Ameren. .

Prairie Wind Transmission –This joint venture between MidAmerican, American Electric Power (AEP) and Westar Energy plans to build 230 miles of 765kV line in Kansas. AEP is acting as project manager; Westar is providing administration and is leading the financing plans. AEP and MidAmerican have an ongoing partnership with Electric Transmission America LLC to develop and invest in high voltage transmission projects.

Southwest Intertie Project – LS Power is building 1,000 miles of 500kV line, with Phase 1 from southern Idaho to the Las Vegas area and Phase 2 running from Wyoming to Idaho. Backed by subscription service, this project requires future wholesale and retail customers to commit to reserve capacity in the line so that LS Power can secure financing for the line's construction. .

Much of the new transmission construction planned by these entities is at 765kV. AEP has developed an industry-wide transmission vision showing the development of a nationwide 765kV grid intended to deliver wind generation to loads. While this is still in the early development stages, primarily encouraging support among policy makers, AEP is partnering with MidAmerican and others to implement specific segments of its vision in Texas, Kansas, and the upper Midwest. Figure Transmission 1 shows AEP's transmission vision. .

As legislators and regulators seek to advance their policy agenda, they face the disaggregated nature of the current transmission investment process. Coordination issues revolve around the transmission planning process as projects span multiple utility territories, multiple state jurisdictions, and even multiple RTOs. Authority for approving siting, issuing permits, and granting of rights-of-way currently reside at the state and local level. Issues arising from this decentralized process have delayed several projects across the country, in many cases for years. Federal policy makers and some utilities see this structure as an impediment to future transmission investment. Recent versions of federal energy legislation include provisions expanding federal authority over planning and siting. .

While it is possible that more federal authority over siting and permitting could relieve the time constraints, it is also possible that federal requirements, such as environmental

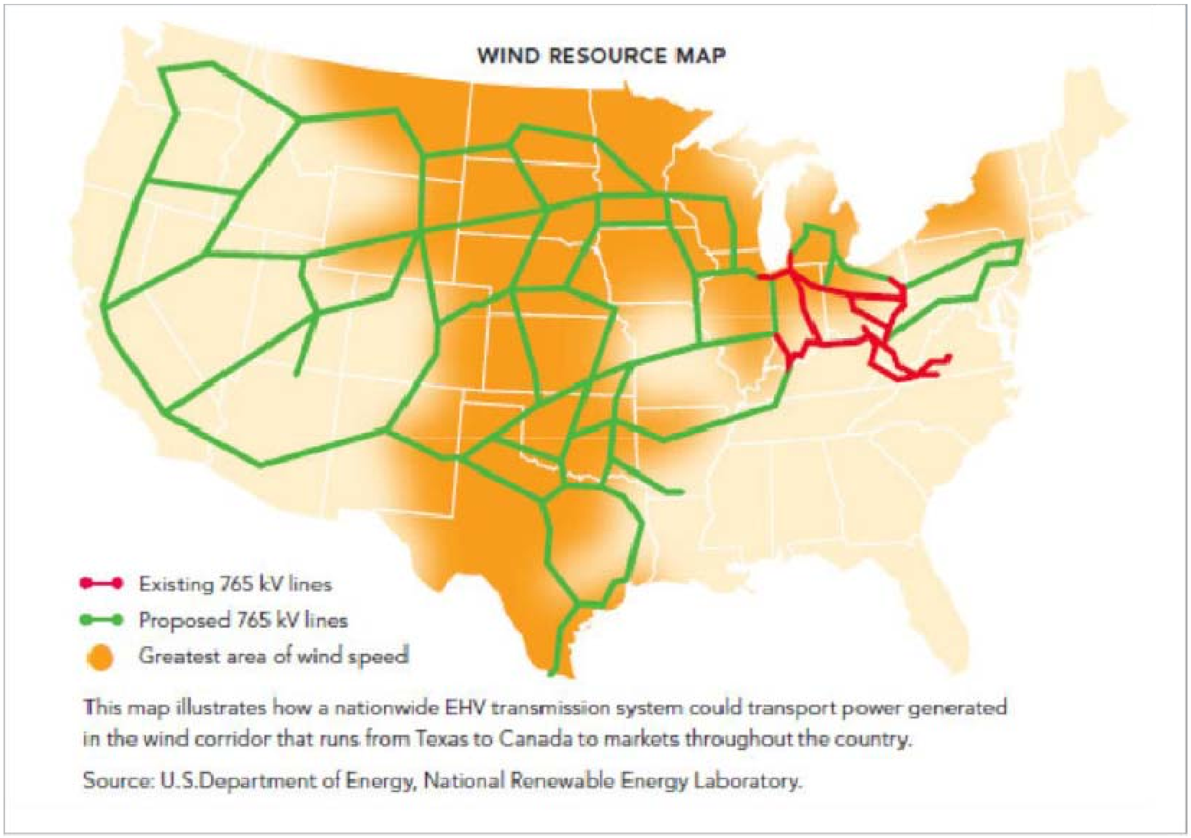

Figure Transmission 1 – AEP Transmission Vision of the Future

impact statements and other hurdles at the federal level, could negate any efficiencies gained over the current more local process. .

Access to capital could also be a limiting factor. However, capital markets have responded positively to recently proposed projects and partnerships. Transmission, with its regulated return, particularly if accompanied by FERC incentives, appears to be viewed as an attractive investment. Awarded on a project-by-project basis, FERC incentives can significantly enhance the cash flow profile of transmission investment.

Demand Drivers: Demand for new transmission is driven primarily by the need for access to renewable energy resources, particularly wind generation. Recent versions of federal energy legislation adopt national renewable electricity standards, mandating the percentage of energy consumption from renewable resources. Even in the absence of this legislation, individual states have established renewable energy requirements or targets, increasing pressure for more transmission development. The Midwest ISO Transmission Expansion Planning process is examining potential scenarios with wind generation ranging from 15,000 to 70,000 megawatts. Just within the Midwest ISO footprint, over $30 billion of transmission investment could be needed to connect and deliver this amount of wind energy.

Climate legislation also has the potential to drive significant demand for new transmission investment. A climate bill resulting in a carbon price of $25-30 per ton could radically change market dispatch (favoring wind and gas generation over coal-fired power). This could lead to significantly different flows on the transmission system.

New transmission could be required to accommodate this new dispatch pattern, while minimizing transmission constraints and related congestion.

Traditional load growth and reliability issues remain drivers for future transmission investment. Load growth has historically driven new transmission investment, both regionally and in localized areas. In addition, significant portions of the transmission system are now 40 to 60 years old and will require new investment to replace or rebuild them. By 2030, it is also possible that plug-in electric cars can make significant penetration into the market place, impacting transmission needs as off-peak loading becomes more critical.

Discussion Paper
Natural Gas
November 2, 2010

Overview: The consensus in the utility industry is that natural gas will be available for the long term, but the availability and price will be driven by global market conditions, technology and geopolitical factors. Due to technological breakthroughs in drilling and extraction methods, vast natural gas reserves locked in shale formations are now viable and economic.

Most experts believe that natural gas will be a preferred clean energy resource over the next 20 years and potentially beyond. As we enter a carbon-constrained environment, natural gas will be the bridge fuel for power generation as emerging technologies in electric generation and transportation evolve.

Natural gas power plants can be built much more quickly and inexpensively than large, baseload plants fueled by coal or uranium. They also emit half as much carbon as coal-fired plants with no sequestration technology. In addition, with potential transformative changes from distributed generation (fuel cells, microturbines), natural gas could play a key role in the modernization of energy supply.

The projected growth of renewable energy resources (which could rely on natural gas-fired generation to provide back-up supply) will also drive demand in natural gas. Recently, the combination of the dramatic increase in unconventional production from the shale formations and a depressed economy have pushed gas prices lower, from a high of $13.57 per MMBtu in July 2008 to $3.84 per MMBtu in April 2010. Utility projections of natural gas prices over the next 20 years in real $2009 range between $5.00 and $9.00 per MMBtu.

While potential global and domestic gas reserves are plentiful, the natural gas market will remain volatile as growing demand and emerging supplies seek a market balance. We will continue to see opposition to drilling and extraction methods and concerns about water consumption and groundwater contamination related to shale exploration. In addition, the nation's pipeline and storage infrastructure is constrained and will require major investments to transition to new unconventional sources of supply. These investments are being made, such as Mid Continent Express (KinderMorgan), Carthage-Perryville (Centerpoint), and Fayetteville Express (Texas Gas Transmission). Nevertheless, most experts believe that there will be a transition to natural gas over the next five to 15 years as the industry seeks to reduce carbon emissions and increase flexible back-up generation to support the build-out of renewable energy.

Demand Drivers: The utility view is that natural gas will remain a preferred fuel for residential, commercial and industrial processes. Due to pending carbon legislation, renewable portfolio standards, energy efficiency standards, and the potential for distributed generation technologies, demand for natural gas will grow. As new technologies for clean coal become more mature and as advanced nuclear becomes more mature, these technologies could begin to displace natural gas, but we do not see this until the second half of our 20-year time frame.

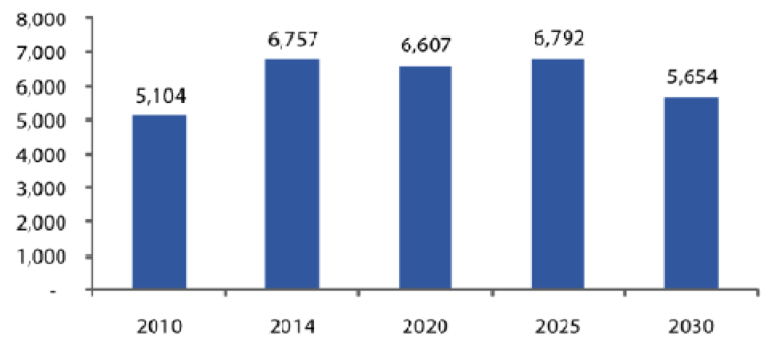

Figure Natural Gas 1 – Natural Gas for Electric Generation 2101-2030 (TBtu)

The U.S. demand for natural gas has ranged from 18 to 23 Tcf in the past 20 years. In 2009, the overall U.S. demand was 22.8 Tcf, with 6.9 Tcf consumed for electric utility purposes. Globally, the demand for natural gas has been approximately 100 Tcf per year. Figure 1 shows the projected deman for natural gas demand for electric generation from 2010-2030.

Supply Drivers: New supplies of natural gas, combined with reduced demand, have depressed gas prices in 2009. After steadily declining from 1967 through 2000, U.S. natural gas reserves are increasing. New supplies are coming from unconventional sources, mostly shales discovered in Texas, Louisiana, Arkansas, Pennsylvania and elsewhere; see Figure 2. However, given the high capital and operating costs of shale exploration and the low current prices for gas, many drilling projects are now uneconomical. Producers have sharply reduced their drilling activity in recent months as they await improved demand conditions.

Domestic growth of proven natural gas reserves has increased 49% from 1998-2008, from 164 to 245 Tcf, representing over 10 years worth of current domestic consumption. Probable reserves have increased from 1,532 Tcf in 2006 to 2,074 Tcf in 2008, approximately 90 years of domestic consumption at current rates. Shale deposits have become the engine for major supply growth. These shale sites represent an additional 616 Tcf of U.S.reserves alone or approximately 30 years of consumption. Significant conventional reserves in remote Alaska and McKenzie Delta represent an additional 35 Tcf of proven reserves, although access to these reserves requires construction of a 1,700-mile pipeline from the northern coast of Alaska/Canada to the U.S. markets at a cost of approximately $30 billion.

While most U.S. supply is being satisfied by domestic sources, in recent years when prices were much higher, imported gas in the form of Liquefied Natural Gas (LNG) played a larger role in the supply picture. Cooling natural gas to about -260 degrees Fahrenheit results in the condensation of the gas into liquid form, reducing the volume to 1/600 of the gaseous state, making tanker transportation possible. Today, global demand for LNG is growing at its lowest rate in more than a decade due to the global recession and increasing confidence in U.S. gas production and reserves. In 2009, 0.451 Tcf of LNG was imported into the US for consumption, down from a high of 0.771 in 2007. The slowdown in LNG demand is happening as the LNG industry is about to increase supply capacity more than 100 percent over the next three years. While the change in market conditions is likely to lead to some liquefaction development projects being delayed or cancelled, investment to date in new liquefaction capacity has created a more robust international LNG market. LNG infrastructure provides access to vast

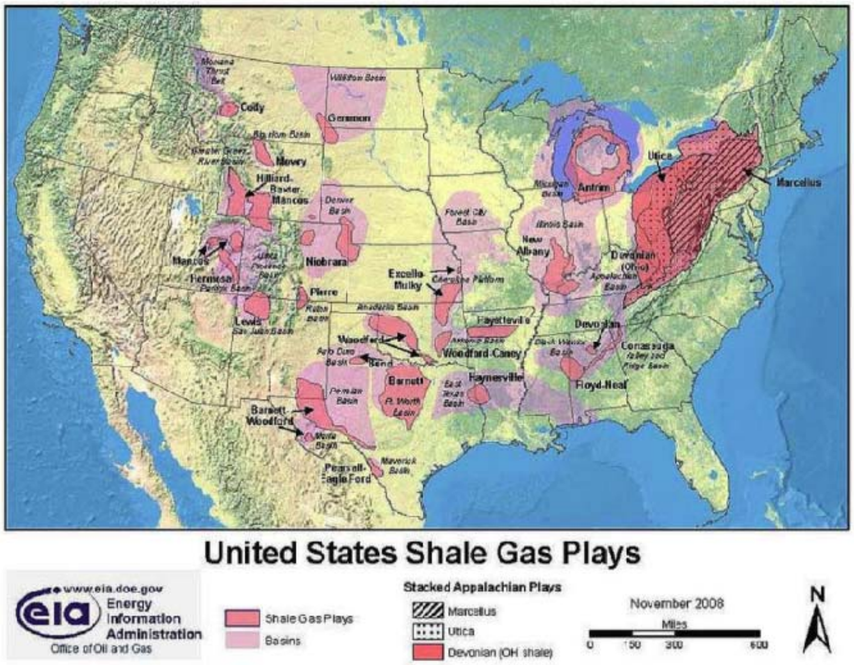

Figure Natural Gas 2 – Shale Discoveries in the U.S.

proven and unproven gas reserves in Russia, the Middle East and other parts of the world. Liquefaction capacity for LNG is expected to increase from 6.2 Tcf in 2003 to 13.5 Tcf in 2013, primarily from Qatar, Trinidad, and Angola. Global reserves are estimated to be 6,200 Tcf, approximately 60 years of reserves at current global consumption rates. Russia, Iran and Qatar represent more than 50% of these global reserves. There are predictions of vast, but unproven global natural gas reserves that may be available for long-term production. The extraction methods developed in the U.S. for shale gas may be employed in Europe/Russia and the Middle East to access new production areas. Approximately 1,550 Tcf of reserves are estimated to exist above the Arctic Circle. Government policies and environmental restrictions threaten access to production areas and extraction of natural gas from known domestic reserves and from new reserves in shale and potential reserves in methane hydrates. Drilling restrictions on federal land have stranded 67% of oil reserves and 40% of natural gas reserves in America's western states and Alaska. Recently, there has been opposition to the new drilling and extraction methods utilized in the shale formations due to their fresh water requirement and discharge of drilling fluids. This opposition may increase in response to the recent oil spill in the gulf. Globally, a majority of the imported LNG originates in politically volatile countries, exposing the U.S. to geopolitical risks related to reliance on LNG in place of other sources of domestic supply.

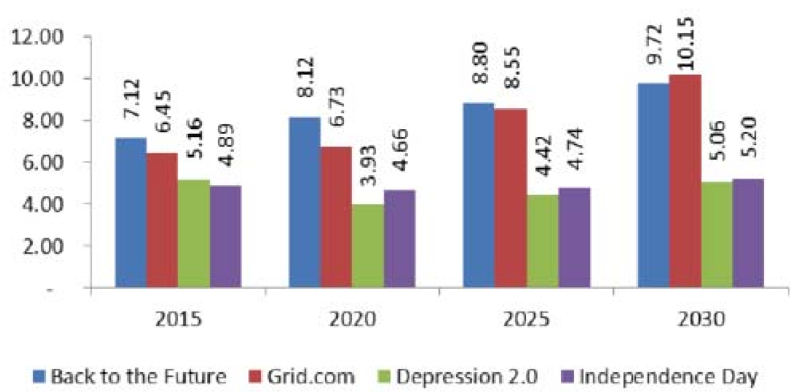

Figure Natural Gas 3 – Henry Hub Natural Gas Price (2009 $/MMBtu)

Existing pipeline and storage infrastructure is currently constrained and will need significant build-out to meet growing demand and supply. New interstate pipeline capacity is required to access the new shale production basins. Large build-outs will require significant capital and will likely encounter numerous environmental hurdles.

The utility viewpoint: The combination of the economic slowdown and the increase in supply related to shale production in the U.S. has caused gas prices to decline from a high of $13.57 per MMBtu in July 2008 to $3.84 per MMBtu in April 2010. The utility industry's view is that economic growth (GDP) will return in the next 12-18 months and will continue at an average annual rate of 2.2%-2.4%. This economic outlook implies that the current high storage levels can be worked off, thereby increasing price pressure from currently depressed levels. Ameren's view of natural gas prices over the next 20 years in real $ 2009 ranges between $5.00 and $9.00 per MMBtu, see Figure 3.

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In recognition of the new paradigm of research, development and deployment that is needed to reframe energy research, much effort has been placed on the context and environment for research. Scientific advancement is critical, but so is the concurrent alignment of other inputs to the research process to ensure that gains are made as cost effectively and as efficiently as possible in light of the real world challenges that could potentially inhibit their impact. As Narayanamurti and colleagues state, the "importance of improving and better aligning the management and structure of existing and new energy innovation institutions to enhance the coordination, integration, and overall performance of the federal energy –technology innovation effort (from basic research to deployment) cannot be overemphasized."[i] Any discussion of energy innovation must clearly also include conversations about innovative teams that integrate multiple perspectives and leverage key strengths, operate within partnership frameworks in which intellectual property and other more individually-focused incentives and limitations are open and effectively managed, and that are consistently devoted towards not just scientific advancements, but on realizing full value and impact of any potential solution. In discussing the role of public-private partnerships, Anadon and colleagues articulately state that "strategic decisions regarding partnerships must include the distribution of resources by technology, the types of overlapping interests to pursue and market failures to address, and the complimentary abilities needed to achieve strategic goals."[ii]

At the federal level attention is being placed on the concept of team and how to best manage funding policies and processes to encourage novel approaches that can accelerate the pace of exploration. For example, the Advanced Research Projects Agency – Energy (ARPA-E), whose mission it is to "foster innovation and support game-changing technologies that could transform the global landscape", not only makes a grant to an organization and awaits its report but instead makes a grant and provides wrap around services to provide technical help (Program Team), administrative assistance to leverage government economies of scale and purchasing power (Operations Team), stakeholder communication experience (Outreach Team) and assistance with bringing new technologies to market (Commercialization Team).[iii] While the effectiveness of this approach has yet to be fully proven, it is clear that the targeted outcome of change has forced a redesign of the research process that brings greater focus on increasing the impact of new knowledge on other researchers, professionals in the field and the lay community. It also forces research teams to focus earlier on issues of intellectual property to prevent additional delays in commercializing findings.

Especially as the composition of research teams diversifies, intellectual property management will become a significant factor in acquiring resources to sustain partnerships and propel new technologies forward, while providing numerous opportunities for resource conflict within the team. Indeed the profit and prestige incentives of any transformational technology can create individual incentives for organizations that are so strong they increase the risk of undermining the collaborative approach necessary to sustain the team. Attention must therefore be paid to identify and manage the sources of potential conflict. The findings of the National Research Council in the recent report on *Managing University Intellectual Property in the Public Interest*[iv] include several recommendations that address these risks and how best to manage them. For example, teams could adopt management oversight workgroups with representation from its constituents who review the progress and help decide which advances have the most potential and how best to move forward different findings. This can help ensure that advancements are valued correctly, that priorities are decided by the group and individual findings cannot be controlled by any single group member. This operating framework can create substantial value for the group but must carefully and cautiously be constructed in consideration of each member's own values, limitation and flexibility.

In order to achieve more for Missouri attention in research must also be devoted to other statewide factors that could inhibit or facilitate even the most successful energy innovative team. If the public doesn't understand the full extent of the energy challenge then citizens may make decisions that undermine the ability of the state to fund or otherwise manage emergent challenges and opportunities. Market and community outreach efforts new to be led to help cultivate a statewide willingness to adopt potential solutions. Communities need to be informed and prepared to adopt new technologies. Sufficient public funding should be accessible to allows for the investment in the necessary infrastructure to support energy technologies. If sufficient numbers of skilled workers aren't available then the state's ability to produce and capitalize on new opportunities can be limited. Companies may not have sufficient human capital to implement changes or take on new production. If the companies cannot operate in clearly superior ways then hard management decisions will have to be considered that could impact the location and size of investments. Having a workforce with the technical capacities required in the future can help protect investments in Missouri and grow Missouri's energy leadership. Research should therefore be conducted to understand the workforce demands of the energy future and work with the state employment and educational system to identify ways to ensure that such a workforce is being developed. Such efforts may require innovative management of the pathways that grow adolescents into technical fields or retraining programs that help skilled workers translate their abilities to new fields and roles.

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[i] V. Narayanamurti, L.D. Anadon, and A.D. Sagar (2009). Transforming Energy Innovation. Issues in Science and Technology (57).

[ii] L.D. Anadon, M. Bunn, G. Chan, M. Chan, K.S. Gallagher, C. Jones, R. Kempener, A. Lee, and V. Narayanamurti. DOE FY 2011 Budget Request for Energy Research, Development, Demonstration and Deployment: Analysis and Recommendations. Cambridge, Mass.: Report from the Energy Technology Innovation Policy research group, Belfer Center for Science and International Affairs, Harvard Kennedy School, April 2011. Page. 5.

[iii] Energy Transformation Acceleration Fund, Advanced Research Projects Agency – Energy (ARPA-E) FY2011 Congressional Budget Proposed Appropriation Language, retrieved electronically http://arpa-e.energy.gov/LinkClick.aspx?fileticket=FzuPHgdX6r8%3d&tabid=184 (October 13, 2010).

[iv] Committee on Management of University Intellectual Property: Lessons from a Generation of Experience, Research, and Dialogue; Stephen A. Merrill and Anne-Marie Mazza, *Editors*; National Research Council. (2010). Managing University Intellectual Property in the Public Interest.